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Dysphonia in Smokers of Combustible Cigarettes and E-cigarettes Measured Using the Filipino Voice Handicap Index

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ABSTRACT

Objective: To determine the prevalence of dysphonia, defined as any perceived voice pathology, in conventional cigarette smokers and e-cigarette users and to quantify and compare the Filipino Voice Handicap Index (VHI) scores of the two groups based on the mean scores for each of the three domains of this tool, as well as the mean total score for each group.

Methods:

Design: Cross-sectional study

Setting: Tertiary National University Hospital

Participants: 52 adults between the ages 18-65 with no previously known laryngeal illness or condition were divided into 26 conventional smokers and 26 e-cigarette users and completed the self-administered Filipino Voice Handicap Index.

Results: The prevalence of impairment in the sample using a total VHI score cut-off of 18 was 17.31% (9 out of 52, CI 8.23-30.32%) and the prevalence of dysphonic symptoms in the sample was 86.54% (45 out of 52, CI 74.21-94.41%). There were no significant differences between smokers and e-cigarette users for impairment using this cut-off (z: -1.36, p: .07) and dysphonic symptoms (z: 0.4063, p: .68). The prevalence of moderate impairment was 3.85% (1 out of 26, CI: 0.10-19.64%) among those using e-cigarettes; and 1.92% (1 out of 52, CI: 0.04-10.26%) among the entire sample population.

Conclusion: There appears to be no statistically significant difference between the Filipino VHI scores of conventional smokers and e-cigarette users. Further inquiry into the subject would benefit from a larger sample size, comparison with a control group, inclusion of other factors relevant to the development of dysphonia, and correlation with objective means for voice analysis.

Keywords: *dysphonia; smoking, vaping; e-cigarette, cigarette, voice handicap*

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The Global Adult Tobacco Survey (GATS) in 2015 estimated that 0.8% of the Philippine population use electronic cigarettes or e-cigarettes.[1] As opposed to combustible cigarettes that burn tobacco, these handheld devices vaporize electronic liquids (e-liquids) at a lower temperature to produce a wide array of flavors and vapor.[2] E-liquids or e-juice potentially contain substances such as nicotine derivatives, impurities, heavy metals, and volatile organic compounds.[2] These are marketed as an alternative to smoking, with the Republic of the Philippines House of Representatives issuing a resolution in 2018 urging the Department of Health to promote harm reduction measures including the use of e-cigarettes.[3] Some physiological effects of e-cigarettes have been investigated by several studies but none of these focus on dysphonia.[4-6] Cardiovascular, pulmonary, and immunologic effects have been noted, but the associated health consequences of e-cigarette use have yet to be determined over the long-term.[4-6] A single case reported a vaping-related vocal fold injury in a 55-year-old female with a 20 pack-year tobacco history after misuse.[7]

Smoking has been demonstrated to have an association with dysphonia in the Korean general population.[8] Female smokers were also demonstrated to have significant group differences in dysphonia severity index scores compared to nonsmokers.[9] A meta-analysis showed that cigarette smoking had an intermediate level significant difference for the physical subscale of the Voice Handicap Index, although this was not observed for the functional and emotional subscales. This study also showed an intermediate level significant difference for pitch (F0) and maximum phonation time.[10] However, there seems to be conflicting evidence on the effect of smoking on perceived vocal handicap, with other studies suggesting that smoking does not affect patient handicap in relation to dysphonia.[11] In the case of e-cigarettes, the data is lacking even further. Being a relatively new technology, the possible clinical effects of e-cigarette use have yet to be determined.[4] This is a relevant area for investigation as voice disorders significantly affect patients' quality of life and incur considerable healthcare costs.[12]

This study aims to contribute to the lacking epidemiological data on e-cigarette health effects in relation to dysphonia. Specifically, we aim to determine the prevalence of dysphonia, described as any perceived voice impairment, in conventional cigarette smokers and e-cigarette users and to quantify and compare psychosocial handicap by comparing the Filipino Voice Handicap Index (VHI) mean scores of the two groups for each domain as well as for total scores.

METHODS

With University of the Philippines Manila Research Ethics Board (UPMREB 2019-449-01) approval, this cross-sectional study considered for inclusion, adults between the ages 18-65 with no previously known laryngeal illness or condition. Prospective participants were excluded if they had been diagnosed with chronic respiratory disorders such as asthma and chronic obstructive pulmonary disease, had frequent episodes of heartburn, reflux, chronic cough, dysphagia, or if they were previously diagnosed with medical conditions consistent with laryngopharyngeal reflux, or gastroesophageal reflux disease. Two groups were defined - conventional cigarette smokers, or any participant who at the time of the study had exclusively smoked at least 1 combustible cigarette per day for at least one year, and e-cigarette smokers or participants who at the time of the study had used a smokeless nontobacco device for at least one vaping session once daily. The calculated sample size was 26 for each group to demonstrate a large effect size of 0.8 between two means, a type I error rate at 0.05, and power at 0.80 using the following formula:

$$d = \frac{\text{Mean}_{\text{group1}} - \text{Mean}_{\text{group2}}}{\text{Pooled Std Deviation}}$$

The study was not limited to recruiting e-cigarette users that had been exclusively vaping for at least one year regardless of the possibility of dual use with conventional cigarettes because of the limited population of vapers.

Participants were recruited mainly through face-to-face meetings in the Metro Manila area. Snowball sampling was also employed as prospective participants were able to refer other potential study participants. After obtaining informed consent in both English and Filipino, demographic data and frequency and quantification of smoking and vaping were recorded. The Filipino VHI was then accomplished by each participant. The VHI is a self-administered questionnaire consisting of 30 statements of reactions and experiences to voice disorders, divided into functional, emotional, and physical subscales.[13] A five-point Likert scale is used (0-never, 1-almost never, 2-sometimes, 3-almost always, 4-always), with the mean score for each of the 10 questions per subscale corresponding to the subscale score.[13] Minimal handicap is considered for a total score of 0 to 30, a moderate handicap is reflected by a total score of 31 to 60, and a total score of 61 to 120 is associated with severe handicap.[14]

Deidentified data were tabulated, encoded, and summarized using Microsoft Excel v2016 (Microsoft Corp., Redmond, WA, USA). Statistical analysis was performed using STATA Statistical Data Analysis 13 software (StataCorp LLC, College Station, TX, USA). Descriptive statistics such as means, standard deviations, frequencies and percentages were used to provide an overview of the study population. A series of independent

t-tests were used to compare age between the groups, as well as compare the total and sub-scale scores of the Filipino VHI tool across select variables; and chi-square tests of association were rendered to compare sex, education, and duration of use between the said groups. Pearson correlation was used to determine a relationship between age and the ratings for the same tool. The prevalence for impairment was calculated for e-cigarette users and conventional smokers as proportions with confidence intervals. Odds ratios were also computed for the presence of impairment and dysphonic symptoms. The level of significance for all sets of analysis was set at a *P*-value less than .05 using two-tailed comparisons.

RESULTS

There were 52 participants in this study, 26 each in the combustible cigarette and e-cigarette groups, respectively. There was no concurrent or dual use of combustible cigarettes and e-cigarettes among the participants. The former had 20 (76.92%) males and 6 (23.08%) females with ages ranging from 20 to 60 years of age (M = 34.19; SD ± 10.12). The latter had 18 (69.23%) males and 8 (30.77%) females with ages ranging from 21 to 36 years of age (M = 28.50; SD ± 4.70). The Filipino VHI scores according to sex are compared in *Table 1*. Participants who used e-cigarettes tended to be younger (t: 2.60, df: 50, p = .01) than those who used combustible ones. The correlation of Filipino VHI scores with age is shown in *Table 2*. There was no association with the VHI scores for the variables of age and sex.

Table 1. Comparison of Filipino VHI scores according to sex

VHI domains	Females *M ± SD*	Males *M ± SD*	Student *t*	t test *p-value*
Functional	4.14 ± 5.23	4.18 ± 6.57	-0.02	.98
Physical	4.07 ± 3.56	3.87 ± 5.47	0.13	.90
Emotional	1.29 ± 2.05	2.11 ± 2.75	-1.01	.25
Total	9.50 ± 6.45	10.16 ± 11.76	-0.20	.84

Note: n = 52, degrees of freedom = 50

Table 2. Correlation of Filipino VHI scores with age

VHI domains	Pearson correlation		
	r	*95% CI*	*p-value*
Functional	-0.07	-0.34, 0.21	.62
Physical	-0.17	-0.42, 0.11	.23
Emotional	0.00	-0.27, 0.27	.99
Total	-0.12	-0.38, 0.16	.39

Duration of use for the combustible cigarette group was less than 6 months for 1 (3.85%), 6-12 months of use for 1 (3.85%), 1-2 years for 2 (7.69%) and more than 2 years for 22 (84.62%) participants. For the e-cigarette group, the duration of vaping was less than 6 months for 4 (15.38%), 6-12 months for 1 (3.85%), 1-2 years for 8 (30.77%), and more than 2 years for 13 (50%) participants. Smokers of combustible cigarettes in the sample tended to have longer duration of use, compared to vapers (χ^2 (3, N = 52) = 7.71, p = .03). Cigarette use of the combustible cigarette group was characterized as light, moderate, and heavy. Of the combustible cigarette group, 18 (69.23%) had light use or smoked less than 10 sticks per day. Moderate use, or smoking of 11-19 sticks per day, was reported by 6 (23.08%); and heavy use, or consumption of more than 20 sticks per day, was reported by 2 (7.69%) participants. Nicotine content of e-liquid consumed by the e-cigarette users were as follows: 1 (3.85%) consumed e-liquid without any nicotine (0 mg/mL), 17 (65.38%) consumed e-liquid of 1-6 mg/mL, 6 (23.08%) reported consumption of e-liquid of 7-12 mg/mL and 2 (7.69%) consumed e-liquid with more than ≥ 13 mg/mL.

Of the combustible cigarette group, 4 (15.38%) were of high school level and 22 (84.62%) had collegiate level of education. For the e-cigarette group, 1 (3.85%) completed elementary schooling, 6 (23.08%) reached high school level, and 19 (73.08%) attained collegiate level education. Participants who reached college level tended to have lower ratings for the physical (t: 4.33, df: 50, p<.01), and total sub-scale items (t: 3.07, df: 50, p<.01) than those who reached elementary and high school only. This was also apparent to a certain extent for the functional sub-scale (t: 1.68, df: 50, p=.10).

The average functional subscale score for the combustible group was 3.58 ± 4.43, and for the e-cigarette group was 4.77 ± 7.60 (p = .49). For the physical subscale, the average score for the combustible group was 3.46 ± 4.25 and for the e-cigarette group it was 4.38 ± 5.69 (p = .51). The average for the emotional subscale for the combustible group was 1.81 ± 2.38 and for the e-cigarette group it was 1.96 ± 2.82 (p = .83). The average total scores were 8.85 ± 7.64 and 11.12 ± 12.86 (p = .44) for the combustible group and e-cigarette group, respectively. There was no significant difference between the average subscale and total scores for the two groups.

Using a cut-off for total VHI score of 18 to indicate impairment, there were no significant differences between smokers (3 out of 26; 11.54%) and e-cigarette users (6 out of 26; 23.08%) using a test of proportions (z: -1.36, p = .17). The prevalence of impairment in the sample using this cut-off was 17.31% (9 out of 52; CI 8.23-30.32%). The prevalence of dysphonic symptoms in the sample was 86.54% (45 out of 52; CI 74.21-94.41%) and similarly there was no noted difference between e-cigarette users (23/26; 88.46%) and smokers (22/26; 84.62%) in terms

of this outcome (z: 0.4063, *P* = .68). One e-cigarette user reported a total VHI score of 58, corresponding to moderate impairment. The calculated odds ratio for the presence of dysphonic symptoms in e-cigarette users compared to smokers was 1.39 [CI: 0.28-6.95]. E-cigarette users had 2.3 [CI 0.51-10.41] odds of having impairment using a cut-off of 18. With a cut-off 20 on the other hand, e-cigarette users had odds of 3.6 [CI: 0.65-19.84] compared to smokers. There was no noted association for the variables of age, study groups and sex across the scale scores.

DISCUSSION

This study showed that the prevalence of dysphonic symptoms in the sample was 86.54% (45 out of 52; CI 74.21-94.41%). There was no noted difference between the prevalence among e-cigarette users (23/26; 88.46%) and smokers (22/26; 84.62%) (z: 0.4063, *P* = .6845).

Although local prevalence studies are lacking, two cross-sectional studies in United States-based populations by Cohen and Benninger, respectively, reported a prevalence of dysphonia of 0.98% and 1.7%.[15,12] In South Korea, Cho reported a prevalence of 6.7%.[16] The prevalence of impairment in our sample using a cut-off of total VHI of 18 was 17.31% (8.23-30.32%). Cho's study[16] was a nationwide cross-sectional survey that was representative of the Korean population as it employed a more complex, stratified, multistage probability sampling design. Benninger's study[12] employed a large administrative database from which nationwide estimates were projected. Our current study on the other hand, only employed convenience and snowball sampling within Metro Manila. Also, for the Korean study,[16] the presence of dysphonia was self-reported instead of based on a Voice Handicap Index. Cultural differences in the perception of dysphonia or impairment cannot be disregarded.[17]

The Voice Handicap Index originally developed by Jacobson and colleagues has been established as a reliable tool for identifying patients with vocal dysfunction.[18] Psychosocial handicap from voice disorders is psychometrically measured using this validated questionnaire.[19] A Filipino version was adapted by Umali and Hernandez in 2006, which was deemed by Lim and colleagues to be compatible with other versions of the VHI.[13]

In our study sample, participants who attained collegiate level education tended to have lower ratings for the physical (t: 4.33, df: 50, p<.01), and total sub-scale items (t: 3.07, df: 50, p<.01) than those who completed elementary and high school levels only. Lim and colleagues reported similar findings of significantly higher scores in the primary and secondary education group compared to the college education group.[13] There was no association shown for the variables of age, study groups and sex of the participants across the scale scores in this study. In contrast, Lim's study reported significantly higher scores for patients < 40 years old, female, and who were voice professionals.[13] A possible explanation for the higher scores reported was that Lim's study[13] involved patients already known to have dysphonia from a tertiary referral hospital, whereas this study was limited to participants with no previously diagnosed condition that could predispose to dysphonia.

Several studies have shown an association between smoking and dysphonia. Awan's study implied the difference between smokers and nonsmokers could herald changes in vocal function at an early stage.[9] Pinto and colleagues described the influence of smoking on acoustics parameters - in particular, smoking decreased fundamental frequency values in both sexes.[20] Byeon explored the association between lifetime cigarette smoking and dysphonia in the Korean general population based on a national health survey, and implied that chronic smoking has a significant relationship with dysphonia.[8] An odds ratio of 1.8 was reported for current smokers in terms of self-reported voice problems compared to non-smokers.[8] Another study by Byeon explored the relationships among smoking, organic, and functional voice disorders in the Korean general population and found that current smokers were more likely have organic voice disorders compared to nonsmokers (with an odds ratio of 3.22).[21] The effect of smoking on dysphonia as suggested by Voice Handicap Index (VHI) scores has yet to be established as conflicting data exists.[11] In Polish and Persian studies, female smokers were found to have higher mean VHI total scores compared to dysphonic patients, but had lower mean VHI total scores for a Greek study, as well as one by Taguchi as interpreted by Tafiadis.[22] Glas reported that German patients that were smokers did not exhibit a significant difference in VHI scores compared to non-smokers.[23] Byeon's meta-analysis evaluated smoking effects on voice, and found that smoking had significant and moderate effects on fundamental frequency, maximum phonation time, and the voice handicap index, particularly the physical subscale.[10]

Our study reports an odds ratio of 1.39 [CI: 0.28-6.95] for the presence of dysphonic symptoms in e-cigarette users compared to smokers. Moreover, e-cigarette smokers had 2.3 [CI 0.51-10.41] odds of having a VHI of greater than or equal to 18, which may indicate impairment. Using a cut-off value of 20, on the other hand, revealed e-cigarette users to have odds of 3.6 [CI 0.65-19.84] compared to conventional smokers. The cut-off values for the VHI range from 12 to 20, as different cut-off scores are observed for different versions of the VHI.[22] The prevalence of moderate impairment in the sample was 3.85% (1 out of 26; CI: 0.10-19.64%) among those using e-cigarettes; and 1.92% (1 out of 52; CI: 0.04-10.26%) among the entire sample population of this study and there were no significant difference for moderate impairment observed (z: -1.36, p = .17) for the e-cigarette group compared to the study sample. Only a large effect size is expected to be detected given the sample

size employed by the study. With this, a clinically significant yet small effect size might not be detectable.[24] To the best of our knowledge this is the first local study to characterize dysphonic symptoms experienced by e-cigarette users compared to smokers of combustible cigarettes as measured by the Filipino VHI.

In our sample, e-cigarette smokers tended to come from the younger age group (t: 2.60, df: 50, p: 0.01) than conventional smokers. The GATS released by the Republic of the Philippines Department of Health had previously reported that e-cigarettes are more popular among younger adults aged 15-24 years.[1] E-cigarettes were released in 2003 and had only been in the U.S. market by the mid-2000s[25] and as expected for this study, there was a longer duration of use observed for cigarette smokers (χ^2 (3, N = 52) = 7.71, p = .03).

Although previous studies have reported on the significant effect of smoking on dysphonia and voice disorders, we believe ours is the first study to apply this for e-cigarette use. Studies on the effect of e-cigarettes on the impact of voice disorders as measured by the voice handicap index are sorely lacking in the literature. A case report on vocal fold injury from vaping misuse surmised that inhalation of hot vapor led to a mucosal burn, appearing as an ulcerative and erythematous lesion.[7] Since tobacco-control advocates consider e-cigarettes as a viable option for smoking cessation,[1] knowledge contributing to the clinical effects of smoking, as well as that of its alternatives may prove to be valuable to the medical community as well as the general public. This study also focused on clinical, albeit perceived, effects of vaping, as opposed to previous studies which were mostly pre-clinical.[4]

The literature suggests that causes for dysphonia in adults are multifactorial.[26,27] This study was limited to comparing the Filipino Voice Handicap Index scores of conventional cigarette smokers and e-cigarette users. Despite recruitment not being limited to sole users of cigarette users and combustible cigarette smokers (as a paucity of vaping participants was expected given a prevalence of vaping in the Philippines only estimated to be 0.8%,[1]) dual use was not reported by the participants. Mutually exclusive groups as well as a nonsmoker control group should be recruited for future studies.

Covariates such as income, occupation, alcohol consumption, hydration, existing pain or discomfort and comorbidities should also be recorded and adjusted for as with other studies[5,28] on dysphonia. The cross-sectional nature of the study also precludes its usefulness in establishing causation. Employing a larger sample size may also better demonstrate if indeed there is a difference between Filipino VHI scores of conventional smokers and e-cigarette users, as it may detect a smaller effect size. The incorporation of a follow-up period could be adapted for future studies as this would help establish baseline data for comparison, as well as detect effects that might manifest only after prolonged use. It has been suggested that percentage change in score may be more clinically relevant than the absolute VHI score[26] and it may be of interest to follow changes in the VHI scores through time.

Additionally, future studies may endeavor to correlate the Filipino VHI with objective measures for voice assessment as well as other perceptual ratings. Examples of such are videolaryngostroboscopy, acoustic parameters, the Dysphonia Risk Screening Protocol and Voice-Related Quality of life.[28,29] Notably, the measurement of e-cigarette use has yet to be standardized, and at present different methods are being used to report consumption.[30] Further studies are needed to arrive at precise measures of e-cigarette consumption that would allow comparison with combustible cigarette use.[30]

In conclusion, our study found no statistically significant difference between the Filipino VHI scores of e-cigarette users and smokers. Dysphonic symptoms were present in 86.54% (CI 74.21-94.41%) in the population, while 17.31% (CI 8.23-30.32%) presented with impairment corresponding with a total VHI score of 18 or more. Similarly, there was no significant difference found between e-cigarette users and smokers in terms of these outcomes.

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